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PrAEctiCe

PRAECTICE

POTENTIALS OF AGROECOLOGICAL PRACTICES IN EAST AFRICA WITH A FOCUS ON CIRCULAR WATER-ENERGY-NUTRIENT SYSTEMS

D2.1 - Precission mapping of Agroecological zones in East Africa

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Abstract	This report provides a comprehensive analysis of agroecological practices in East Africa, focusing on Uganda, Kenya, and Tanzania. It examines the variety of sustainable farming techniques, their implementation, and challenges faced by farmers. The report covers demographic analysis, farming practices, and an extensive literature review. Key findings include the diversity of agroecological methods, like mixed farming and agroforestry, and challenges such as labour intensity and market issues. The study emphasizes the need for context-specific strategies and highlights the potential of agroecology in enhancing food security, farmer well-being, and soil health, while also acknowledging the existing gaps and barriers to implementation.
Keywords	Agroecology, East Africa, Sustainable Farming.

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NATURE OF THE DELIVERABLE	**R: DEC: DATA: ETHICS: SECURITY**	
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SEN	Sensitive, limited under the conditions of the Grant Agreement	
Classified R-UE/ EU-R	EU RESTRICTED under the Commission Decision No2015/ 444	
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*** R:** Document, report (excluding the periodic and final reports)

DEM: Demonstrator, pilot, prototype, plan designs

DEC: Websites, patents filing, press & media actions, videos, etc.

DATA: Data sets, microdata, etc.

DMP: Data management plan

ETHICS: Deliverables related to ethics issues

SECURITY: Deliverables related to security issues

OTHER: Software, technical diagram, algorithms, models, etc.

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EXECUTIVE SUMMARY

The report on mapping agro ecological practices in East Africa focuses on three countries: Uganda, Kenya, and Tanzania. Each section details the various agro ecological farming practices used in these regions, emphasizing the adaptability of the farming systems and resilience of local farmers in the face of environmental challenges. In Uganda the survey covered 79 farms across 6 districts. Key practices include mixed farming, mixed cropping, agroforestry, mulching, water harvesting, irrigation, vermicomposting, apiculture, fish farming, and sustainable organic farming. Statistics show mixed cropping as the most prevalent practice, followed by Integrated Pest Management (IPM) and agroforestry. Stakeholders emphasize ecological soil management, integrative farming techniques, resource management, innovative approaches to managing inputs and energy, and preservation of seed diversity. For Kenya the survey included 50 farms in four counties. Practices observed encompass intercropping, mixed farming, organic farming, integrated farming, agroforestry, IPM, conserved tillage, cover cropping, integrated aqua-agriculture, permaculture, and apiculture. Integrated farming is the most adopted practice, followed by agroforestry and organic farming. Other significant practices include intercropping, mixed farming, cover cropping, IPM, and aquaculture systems. Tanzania provided the biggest survey data that spanned 15 regions and 15 districts, involving 245 farmers. Practices identified include intercropping, crop rotation, cover cropping, agroforestry, rainwater harvesting, integrated soil fertility management, contour farming, reforestation, apiculture, and mixed crop-livestock-fish production systems. The most prevalent practices are intercropping, agroforestry and crop rotation, with a significant focus also on cover cropping, crop diversity, and rainwater harvesting.

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ABBREVIATIONS

AE Agro ecological Zones
EA East Africa

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1 INTRODUCTION

Despite the rich and varied landscape of agroecological practices in East Africa, farmers encounter significant challenges, including labour intensity, market-related issues, expertise gaps, input-related challenges, and capital limitations. These obstacles hinder the effective implementation and scalability of agroecological practices. Addressing these challenges is crucial for promoting agroecology and improving the livelihoods of smallholder farmers in East Africa. The study aims to identify and map these agroecological practices, understand their benefits and challenges, and propose solutions to enhance the effectiveness and adoption of agroecological practices in the region

The study had the following objectives.

1. To identify and map agroecological practices in East Africa (Uganda, Kenya, Tanzania).
2. To understand benefits, challenges and barriers faced by farmers in the agroecological transition in East Africa.

This report presents a comprehensive mapping of agro ecological practices across three significant East African countries: Uganda, Kenya, and Tanzania.

1.1 METHODOLOGY

1.1.1 Design

The process begun with a comprehensive literature review and desk research. This step involved scouring academic papers, reports, and publications related to agro ecological practices. At the initial stage, it was important to identify existing practices that farmers engage in. This helped to identify gaps or limitations that was later filled into the survey tool.

Consultations with Regional Experts

To gain a deeper understanding of the specific practices MSU and AAA engaged partners in Kenya, UMU, AFSA engaged partners in Uganda and SAT engaged partners in Tanzania, these ranged from farmer

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based organizations to public extension agents that engage in agro ecology. Each of the participant was selected purposively based on their direct experience and knowledge of agriculture and agroecology in the region. Experts were further engaged researchers, agricultural extension workers, representatives from non-governmental organizations (NGOs), and local farmers. To further help to identify the specific criteria and priorities that should guide the data collection process.

Later the study employed a mixed-methods research design, combining quantitative and qualitative approaches. This design facilitated a comprehensive understanding of agro ecological practices across diverse contexts in Uganda, Kenya, and Tanzania.

1.1.2 Study Areas

The research focused on selected regions in each country, chosen based on their agricultural significance and diversity in agro ecological practices.

- Uganda: Seven districts across different ecological zones.
- Kenya: Four counties representing various agro ecological conditions.
- Tanzania: Fifteen regions across the country, each with distinct agricultural characteristics.

1.1.3 Data Collection Methods

The process incorporates a range of data collection methods drawn from household surveys, focus group discussions, and participatory approaches to gather information on agro-ecological practices and their impact.

Survey: Field surveys was conducted in the three East African countries to gather data on the existing agro ecological practices. Structured questionnaires were administered to farmers in the selected areas in the different Agro ecological zones. These surveys captured information on farming practices, crop types, livestock management, pest control methods, water management, and soil conservation techniques using the agro ecological approach.

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Interviews: Semi-structured interviews were conducted with key stakeholders, including farmers, and NGO/CBO representatives. These interviews provided deeper insights into the motivations, challenges, and benefits associated with different agro ecological practices.

Focus group Discussion: Focus group discussions were conducted with the key stakeholders mainly leader of agroecology organizations to identify the farmers that practice agroecology in the different agro ecological zones

Field Observations: Researchers from SAT, AAA, and UMU conducted field visits to observe farming practices firsthand, assess the local environment, and gather contextual information that might not be captured through surveys and interviews.

1.1.4 Sampling Strategy

Purposive Sampling: In each study area, farms were purposively selected to ensure a representative sample of the agricultural practices in that region and with focus on only farmers that practice agro ecology.

1.1.5 Data over view

Number of entries for data analysis were 347 with Tanzania contributing 220 entries. These were made from 36 unique counties or districts – in Kenya counties were taken to be the addiministrative units while for Tanzania and Uganda districts were picked. Bungoma county had the highest number of entries at Bungoma 40 entries in Kenya with no missing values. Farmer data had 331 entries with 322 unique names, most frequent is Weyama S.H.G (3 entries). 16 missing values. Latitude: 294 non-null entries, ranging from -10.72008 to 24.830072. 53 missing values. Longitude: 294 non-null entries, ranging from 30.892872 to 56.042401. 53 missing values. AE zone: 269 entries from 12 unique zones, most frequent is the eastern zone (54 entries). 78 missing values – Uganda Soil type: 343 entries from 10 unique types, most frequent is Loam (148 entries). 4 missing values.AE practices: 347 entries from 198 unique practices, most frequent is crop rotation (22 entries). No missing values. Crops: 347 entries from 269 unique combinations, most frequent is maize, rice (14 entries). No missing values. Animals: 246 entries from 83 unique types, most frequent is poultry (54 entries). 101 missing values. It should be noted that the same data set was used for D2.3.

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1.1.6 Data management and Analysis

Data Management: Data was sorted and organized to remove any errors which might have come up during data collection and after which it was transferred for analysis

Quantitative Analysis: Statistical methods were used to analyze survey data, including frequency analysis to determine the prevalence of various practices and correlation analysis to explore relationships between different variables.

Qualitative Analysis: Thematic analysis was applied to interview transcripts and field notes to identify common themes, patterns, and narratives related to agro ecological practices.

1.1.7 Ethical Considerations

All research activities were conducted per the ethical research standards of the PrAEctiICe project. Informed consent was obtained from all participants, ensuring confidentiality and anonymity in the handling of their data.

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2 RESULTS

2.1 AGRO ECOLOGICAL ZONES IN EAST AFRICA

2.1.1 Agroecological practices in Uganda

In Uganda, the landscape of agroecological practices is rich and varied, showcasing the depth of agricultural knowledge and the adaptability of its farmers. Mixed farming is a common approach, where multiple species of crops and animals are grown and reared concurrently to optimize land use and resources. For instance, bananas, maize, mangoes, avocados, beans, rosemary, coffee, cassava, guava, and jackfruit are cultivated alongside livestock such as goats, chickens, pigs, and ducks. Such diversity not only bolsters food security but also ensures a continuous supply of different farm products throughout the year.

Looking at the statistics of the survey data collected in Uganda, mixed cropping emerges as the most prevalent practice, with 19.23% of the instances, reflecting a strategic approach to maximizing yields and soil health. Integrated Pest Management (IPM) is the second most common method at 14.10%, indicating a significant emphasis on reducing pest-related crop losses using environmentally friendly techniques.

Agroforestry and soil and water conservation practices are equally utilized, each accounting for 12.82% of the reported cases. These practices illustrate a commitment to preserving natural resources and enhancing biodiversity within farming systems. Farm integration, which involves the combination of different agricultural activities within the same space, is reported in 6.41% of the cases, suggesting a move towards more synergistic and efficient farming operations.

The application of organic fertilizers, fish farming, and intercropping each make up 5.13% of the practices, indicating a moderate uptake. These methods are indicative of a growing awareness and implementation of organic and aquaculture systems in Uganda.

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Less common practices, each with a 2.56% representation, include apiculture, contour farming, mixed farming, and mulching. These activities point towards a varied approach to agriculture that includes beekeeping, strategic land use to prevent erosion, integration of livestock with crops, and soil moisture conservation, respectively.

The study also notes singular instances, each constituting 1.28% of the practices, such as Black Soldier Fly (BSF) farming, companion planting, forest gardening, green manuring, the use of organic crop protectants like ash, raised planting beds, and retention ditches. These less frequent practices may represent experimental or emerging trends in Uganda's agroecological scene, potentially signifying areas for support to facilitate future growth and investment.

A significant number of farmers in Uganda also engage in mixed cropping, which involves growing two or more types of crops in proximity to each other. This is often paired with agroforestry, where trees and shrubs are integrated with crops and livestock. The combination enhances biodiversity, reduces erosion, and improves the water table. For crops, we see a dominant preference for staples like Bananas, coffee, maize,cassava beans, and cocoyams, as well as fruits like avocados, mangoes, and guavas. When it comes to livestock, goats, chickens, and pigs seem to be the popular choices.

Stakeholders also shared their commitment towards fostering integrative farming techniques. This involves intercropping and livestock integration, which contribute to creating a symbiotic relationship between different crops and animals, promoting biodiversity, and improving soil fertility through natural manure provision. Engaging in mixed farming—combining crop cultivation with livestock rearing—is considered to have significant business potential. This approach allows for a diversification of income sources and can help stabilize earnings throughout the year, as different products have different production and harvest times.

Additionally, inter-cropping, the practice of growing two or more crops in proximity, is acknowledged for its potential to maximize land usage and create multiple revenue streams. This practice can also reduce pest and disease pressure, decreasing reliance on chemical inputs and thereby reducing costs. Other researchers have reported that Uganda's agroecological practices are diverse and sustainable, with mixed farming being a common approach (Buyinza, 2018). This diversity enhances food security and

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ensures a continuous supply of different farm products throughout the year. Agroecological intensification practices, such as on-farm diversity, have improved the productivity of banana-based systems in the country (Gambart, 2020). However, the impact of these practices on a broader range of objectives, including environmental and nutritional ones, needs further quantification.

Mulching is another frequently employed practice. Covering the soil around crops reduces water evaporation, suppresses weeds, and improves soil health. Often, mulching is used in conjunction with manuring to enrich the soil and boost its fertility. In regions where soil erosion is a concern, contouring is adopted to reduce the speed of runoff water, thereby conserving the soil. Similar to mulching, in a stakeholders' meeting, participants mentioned the concept of having 365 days of green cover. This was also discussed as a method of soil conservation, preventing soil degradation, and maintaining a healthy ecosystem.

Other studies also confirm that mulching is a widely used practice in Uganda, with significant benefits for soil health and water conservation (Kakaire, 2015; El-Beltagi, 2022). Wang 2021 conducted a study from 2012 to 2013 that involved the cultivation of old and modern wheat cultivars. The study aimed to assess the impact of RFMs on wheat productivity, rainwater use efficiency, soil quality, and economic profitability and to compare the performance of grass straw mulching and plastic film mulching within RFMs. RFMs show potential for enhancing field productivity and rainwater utilization in semiarid regions. Grass straw mulching outperforms plastic film mulching in terms of economic output and soil quality improvement (Wang et al., 2021).

Water is a precious resource in agriculture, and several farmers have turned to innovative techniques like water harvesting, irrigation, and the construction of diversion channels to ensure a consistent water supply. Crops such as coffee, bananas, eggplants, maize, and avocados seem to benefit from these practices. Irrigation is seen as a practice with high business potential, as it allows farmers to grow crops even in dry conditions, leading to better yields and the possibility of multiple cropping cycles per year. Similarly, the construction of soil water and conservation ditches is recognized for its potential to improve water efficiency and crop productivity, which are critical for business sustainability. From other studies done in Uganda, small-scale farmers are facing challenges due to irregular rainfall patterns and water scarcity (Kiggundu et al., 2018). To address this, innovative techniques such as rainwater

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harvesting and small-scale irrigation systems have been proposed (Durodola et al., 2020). However, the development of these techniques is hindered by a lack of community participation and high investment costs (Kiggundu, 2018). Despite these challenges, the potential of rainwater harvesting for domestic and agricultural use has been demonstrated in Mbale, Uganda (Durodola, 2020).

Vermiculture and vermicomposting is another exciting technique that has been adopted by some farmers, which involves using earthworms to decompose organic waste and produce rich compost for the soil. Vermicomposting, the process of using earthworms to decompose organic waste, has been successfully implemented in Uganda, particularly in small-scale urban animal agriculture (Lalander et al., 2015). This method is a viable manure management strategy, with a high return on investment and the potential to produce valuable animal feed protein. The vermicompost and vermi-wash produced are rich in nutrients and can be used as bio-fertilizers Additionally, vermicomposting has been identified as a cost-effective and environmentally sustainable technology for waste treatment, with the potential to improve soil health and increase crop production (Soni & Sharma, 2016). The use of specific earthworm species, such as *Eudrilus eugeniae*, has been highlighted as crucial for the success of vermicomposting (Dominguez, 2016).

Regarding livestock management, apiculture (beekeeping) and fish farming have also been integrated into the farming systems of some regions in Uganda. These not only provide additional income streams for farmers but also play a vital role in pollination and maintaining aquatic biodiversity, respectively. It's worth noting the diverse fruit cultivation, including lesser-known fruits like passion fruits, strawberry guava, turmeric, pineapple, soursop (*Annona muricata)*, dragon fruit, and many others. Among livestock, the rearing of unique species such as black soldier flies and ducks, in addition to the more conventional chickens and goats, underscores the diverse farming strategies in Uganda. The rearing of black soldier flies is another innovative practice that serves multiple purposes: waste management through the larvae's consumption of organic waste, and the production of larvae as a protein-rich feed for poultry or fish. In the existing literature, The integration of apiculture, fish farming, and unique livestock species into farming systems in Uganda has been shown to provide additional income streams for farmers(Tanga et al., 2021; et al., 2013). These practices also play a vital role in pollination and maintaining aquatic biodiversity (Ogello, 2013). The use of insects, such as black soldier flies, as animal

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feed in West Africa has been identified as a promising strategy to improve animal diets and alleviate poverty (Kenis et al., 2014).

Agroforestry is also gaining momentum among agroecological farmers, food forests manifest in some of the farmers whose land is enough to permit the growing of a variety of trees both wild and food trees. These have the potential to improve food diversity. The challenge is some of the species are not known by the farmers and so are their benefits. There is a need for botanists to come up and work hand in hand with the farmers to eradicate this issue. From literature, agroforestry, particularly in the Eastern Agro-ecological Zone of Uganda, has the potential to improve food diversity and rural livelihoods (Basamba et al., 2016; Okorio et al., 2004).

However, the adoption of agroforestry practices is influenced by various factors, including gender, age, education, and access to credit and extension services (Basamba, 2016). The involvement of farmers and stakeholders in designing agroforestry interventions is crucial for their success (Okorio, 2004). Agroforestry can also mitigate land degradation and provide high-quality dry season fodder and income from marketable products(Leakey, 2017). However, the lack of knowledge about certain tree species and their benefits among farmers in Uganda is a challenge that requires the collaboration of botanists and farmers to address (Basamba, 2016).

Moreover, there's a clear trend towards sustainable and organic farming practices. The use of organic fertilizers and pesticides, strip cropping, cover cropping, and planting throughout the year are notable practices aimed at ensuring ecological balance and long-term productivity. A range of indigenous and sustainable pest management practices are being used and reported by other researchers in Uganda, including the use of wood ash, cow urine, red pepper, and intercropping with repellant plants (Kiwuso et al., 2004). Similarly, measures like companion planting, intercropping, and the use of natural repellents are evident in many farming systems, suggesting a proactive approach to pest management without compromising environmental health. The manufacture of biorationals, which are biological control agents, indicates an innovative approach to managing pests and diseases in a manner that is consistent with agroecological principles. In a stakeholders' meeting held in Kampala in September 2023, there was a notable emphasis on adopting innovative approaches to manage inputs in farming. Production of homemade pesticides and fertilizers, as well as bio-pesticides and bio-fertilizers, were highlighted as

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methods to reduce reliance on synthetic inputs and minimize their negative impact on the environment. Trapping pests, and growing in screen houses are other methods that contribute to more sustainable pest and disease control, as well as improved crop quality in Uganda.

Additionally, in a stakeholders' meeting conducted in 2023 in Kampala, participants revealed that farmers in their constituents practices produce and seed management and preservation agroecological practices. These included the development of granaries for storing crop harvests, which would aid in reducing post-harvest losses and ensuring food sovereignty. Fodder preservation from crop remains after harvesting, through means such as hay and silage production, was pointed out as a valuable practice in sustaining livestock farming by providing adequate feed all year round. Importantly, organizations are also engaging in practices that seek to preserve the integrity and diversity of seed varieties. This includes activities such as seed saving, seed multiplication and seed banking, and the recovery of indigenous seeds, which are crucial in maintaining genetic diversity and promoting resilience against pests and diseases. Parallel to these efforts is the engagement in research to inform policy formulation. For instance, Caritas is conducting research on contamination in water bodies, an initiative aimed at informing policies that safeguard water resources from pollution and degradation. According to RUCID, the use of solar dryers for preserving produce and the grinding of coffee are techniques that add value to the harvest and can lead to better market prices.

Micro-propagation of bananas is a recurring theme in the responses regarding emerging innovations, suggesting that farmers are adopting tissue culture techniques to improve banana yields and quality. This advanced propagation method is seen to produce disease-free and genetically uniform planting material. Similarly, the use of banana plants as shade for coffee crops, instead of *ficus natalensis* trees, has been identified as an effective strategy to reduce the incidence of coffee twig borers, showcasing an innovative approach to pest management while also optimizing land use.

What benefits have Ugandan farmers observed from using the agroecological practices employed on their farm?

Respondents reported better health outcomes, which they attribute to the consumption of higher quality food and the reduced exposure to harmful chemical inputs. These findings suggest that

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agroecological methods are not only beneficial for the land but also have a tangible positive impact on the wellbeing of those who consume its produce. Research in Uganda by other authors has shown that agroecological methods, such as organic farming and crop diversification, can positively impact the environment and human health (Templer et al., 2018; Tesfaye & Tirivayi, 2020). These methods have been associated with better health outcomes and reduced exposure to harmful chemical inputs, improving consumer well-being (Templer et al., 2018).

When it comes to financial aspects, a noteworthy trend is the increased income among the farming community. This boost in earnings is multifaceted, arising from factors like enhanced productivity, superior quality of products, and favorable market prices. The organic nature of the products, a direct result of agroecological practices, seems to be particularly significant in attracting better prices and improving farmers' financial standing. Other sources indicate that the use of agroecological practices, which result in organic products, is particularly significant in attracting better prices and improving farmers' financial standing (Nalubwama et al., 2012). The reduction of costs is another significant benefit identified in the survey. Farmers pointed out that agroecological practices have led to decreased expenditures on inputs, mainly due to the lesser reliance on costly chemical fertilizers and pesticides. Additionally, the practices of waste recycling and the use of manure have further driven down costs, contributing to more sustainable and economical farming operations. Agroecological practices in Uganda, particularly the use of manure and waste recycling, have been found to reduce farmers' expenditures on inputs, such as chemical fertilizers and pesticides(Muhereza et al., 2014).

The subject of soil fertility also emerged prominently in the responses. Farmers frequently lauded the improvements in soil health, a critical component of their work and a testament to the sustainability of agroecological practices. This enhanced fertility is vital for the endurance and prosperity of farming, ensuring that the land remains productive for future generations. A range of studies have highlighted the importance of soil fertility in Uganda's agricultural sector. Stewart emphasizes the need for a holistic approach to soil fertility improvement, including both inorganic and organic sources of nutrients (Stewart et al., 2020). In terms of production, there has been a clear uptick in both yield and productivity, as reported by the respondents in the areas visited. This increase is likely linked to the improved health of the soil and greater biodiversity, along with the adoption of natural manures and

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more effective pest management strategies. These practices contribute to a more robust farming system capable of sustaining higher yields.

The positive effects of agroecological farming on the environment are also noteworthy. There has been an observed improvement in environmental quality and biodiversity, indicating that these practices play a crucial role in promoting ecological balance. The noted enhancements in water retention, increased pollination activity, and effective waste recycling further emphasize the environmental stewardship aspect of agroecological farming. Agroecological farming in Uganda has been found to have positive effects on the environment by other researchers, including improvements in environmental quality and biodiversity (Templer et al., 2018).

The survey uncovered that the benefits of agroecological practices extend beyond just the immediate agricultural returns. Farmers have been able to reap additional rewards such as enjoying enhanced social interactions, such as increased visits from friends. Others have reported that interventions that improve farmers' social networks, such as randomized information exchange, have been shown to increase productivity (Leonard & Vasilaky, 2016).

Challenges faced by Ugandan farmers in implementing the agroecological farming practices and proposed solutions.

Farmers engaged in agroecological farming face several market-related challenges, including poor pricing, fluctuating market prices, and limited availability of markets for organic produce, impacting their profitability and sustainability. They also struggle with input-related issues, such as restricted access to necessary resources, high costs, and inefficiencies of fertilizers during rainy seasons. A notable difficulty is the absence of accessible markets for their products, further exacerbated by inadequate pricing and the complex, costly process of obtaining organic certification.

Many farmers in Uganda grapple with the challenge of long distances to markets, a situation worsened by inadequate road infrastructure and a scarcity of vehicles. This difficulty not only impedes their ability to sell their produce but also inflates transportation costs, thereby diminishing their profits. The absence of suitable transport options, like trucks, further complicates efficient market access. Moreover, high fuel prices and subpar transportation networks amplify these logistical hurdles. These problems impact

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not just product distribution but also the acquisition of farming inputs, rendering the entire supply chain more expensive and inefficient.

Farmers practicing agroecology face other numerous challenges, with labor - both skilled and unskilled. Agroecological methods often demand more manual labor than conventional farming, leading to increased labor requirements and higher costs. This necessitates the development of more efficient farming techniques and support systems to help farmers manage the workload effectively.

The threat of pests and diseases to crops is another significant challenge identified by respondents. The limited effectiveness of organic pesticides compounds this issue, pointing to a need for better-integrated pest management strategies and the development of more potent organic pest control options that conform to agroecological principles. Additionally, parasites, diseases, pests, and other production challenges such as the contamination of water sources and resistance to industrial pesticide chemicals are highlighted.

Capital and resource limitations stand out as substantial obstacles. Farmers often face financial constraints that make it difficult to secure the necessary inputs and materials for agroecological farming. Implementing financial support systems and resource-sharing networks could play a critical role in alleviating these challenges and encouraging the uptake of agroecological practices. Financial challenges, such as putting up credit facilities, indicate difficulties in accessing capital.

Compliance with regulations, such as those from the Uganda National Bureau of Standards (UNBS), presents an operational challenge, suggesting that the regulatory environment may not be fully conducive to or supportive of agroecological practices. A key recommendation is involving farmers in policy-making processes.

2.1.2 Agro ecological practices in Kenya

In Western Kenya, a diverse range of agro ecological approaches are being employed by farmers in the region were documented. The practices observed include intercropping, mixed farming, organic farming, integrated farming, agroforestry, integrated pest management (IPM), conserved tillage, cover cropping, integrated aqua-agriculture system, permaculture, and apiculture. The data on agro ecological practices

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in Kenya, focusing on specific crops grown and animals reared, presents a comprehensive picture of the region's agricultural diversity and sustainable farming techniques.

Review of literature and sampling a particular agro ecological zone in Kenya indicated diverse agro ecological practices in Kenya reflect an adaptive, resilient approach to farming in the region. These practices, often integrated, showcase a commitment to sustainability, ecological balance, and resource efficiency. They hold promise for enhancing food security, climate resilience, and sustainable development in the region. As climate change and environmental degradation continue to challenge traditional farming, these agro ecological practices represent crucial steps towards more sustainable and resilient agricultural systems in Kenya.

Intercropping - This practice, involving crops like cowpea, black nightshade, and maize, demonstrates an efficient use of land and resources. Intercropping supports biodiversity, improves soil fertility, and can lead to better pest control

Mixed farming - Involving a variety of crops such as kales, groundnuts, soya beans, roots, tuber crops, S*esbania*, and lucerne, mixed farming systems are prevalent. These systems, which do not specify the rearing of animals, indicate a focus on crop diversification to enhance soil health and crop yields.
Organic Farming - This method, seen with crops like maize, groundnuts, soya beans, and various roots and tuber crops, emphasizes the avoidance of synthetic fertilizers and pesticides, promoting ecological balance and sustainable crop production.

Integrated farming and agroforestry - Practices combining crops like kales, groundnuts, soya beans, maize, desmodium grass, sesbania, and lucerne with animal rearing (cows, sheep, goats, birds) illustrate a holistic approach. Agroforestry, with crops like sorghum, mangoes, and apples alongside trees like sesbania and lucerne, highlights the integration of agriculture and forestry for mutual benefits.
Integrated pest management and cover cropping - These practices are noted with a variety of crops and livestock, showcasing methods to control pests naturally and improve soil health, respectively.

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Permaculture and aquaculture systems - The presence of diverse crops like mangoes, apples, maize, cowpea, and others, alongside an array of livestock (cows, pigs, fish, sheep, goats, birds) underlines a sustainable, self-sufficient approach to farming that is both eco-friendly and productive.
Organic farming with apiculture - The combination of organic farming with beekeeping (apiculture) indicates an understanding of the importance of pollinators in agriculture, enhancing crop yields and biodiversity. Organic farming emphasizes the avoidance of synthetic fertilizers and pesticides, promoting ecological balance and sustainable crop production.

Agroforestry with cover cropping - This approach, involving a diverse range of crops and trees, emphasizes sustainable land management practices that protect and enrich the soil.
Intercropping, where different crops are grown in proximity, and mixed farming, combining crop cultivation with livestock rearing, are prevalent. These methods offer various benefits, including better land use efficiency, natural pest control, and enhanced soil fertility. They also reduce the risk of total crop failure and increase biodiversity, which is crucial for resilience against climate change.
A significant number of respondents refer to organic farming. This approach eschews synthetic fertilizers and pesticides, relying on natural inputs like compost and biological pest control. It aligns with sustainable farming principles, focusing on maintaining healthy soils and ecosystems.
Integrated farming, frequently mentioned, refers to a holistic approach combining various agricultural practices and ecological principles. This system often integrates crop and livestock farming, waste recycling, and sometimes aquaculture (integrated aqua-agriculture system), aiming for sustainability and self-sufficiency.

Agroforestry, the practice of combining agriculture and forestry, is another common method in the data. This practice contributes to soil conservation, water retention, and biodiversity enhancement. It also provides additional income sources for farmers through timber, fruit, or nuts.
Integrated pest management, a part of several entries, focuses on sustainable pest control methods. Techniques like cover cropping and conserved tillage, aimed at soil conservation, are also noted. These practices help maintain soil health, prevent erosion, and enhance water retention.

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Permaculture, a system based on sustainable land use design, and apiculture (beekeeping), indicate a focus on biodiversity and ecological balance. These practices contribute to pollination, essential for crop production, and sustainable ecosystem management.

Several entries describe a combination of these methods, indicating a trend towards multi-faceted, integrated approaches in agroecology. Such combinations of practices suggest that farmers are not only interested in crop production but also in the overall health of their farming ecosystem.
Looking at the statistics, the landscape of agro ecological practices is characterized by a strong inclination toward integrated farming, which leads to 26.67% of adoption. This practice underscores a holistic approach that synergizes various farm operations to enhance ecological balance and resource efficiency. Following closely, agroforestry accounts for 21.67%, signifying a deep-rooted preference for combining agricultural and forestry technologies to create more diverse, productive, sustainable, and resilient land-use systems.

Organic farming is also significant at 16.67%, reflecting a dedication to sustainable farming without reliance on synthetic fertilizers and pesticides, which is crucial for maintaining ecological integrity and public health. Intercropping, the practice of growing two or more crops in proximity, is utilized in 8.33% of instances, emphasizing the importance of crop diversity in managing pests and diseases and improving yields.

Mixed farming, which incorporates the cultivation of crops alongside livestock rearing, represents 6.67% of the practices. This method reflects an understanding of the symbiotic relationships between plant and animal production systems. Cover cropping and IPM each contribute 5.00%, highlighting efforts to protect and enhance soil health and manage pests with minimal ecological impact.
The integrated aqua-agriculture system, although less common at 3.33%, points to innovative water-based farming practices that synergize aquaculture with crop production. Apiculture (beekeeping), conservation tillage, and permaculture each hold minor percentages ranging from 1.67% to 3.33%, suggesting niche but vital roles in the agro ecological practices within the country.

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2.1.3 Agro ecological Practices in Tanzania

A range of agro ecological practices was revealed. These include intercropping, which involves growing two or more crops in proximity for a range of benefits, such as pest control and maximized use of space. Crop rotation follows, helping to maintain soil health and reduce the spread of crop-specific pests and diseases. Cover cropping, another significant practice, protects the soil from erosion and helps to improve its quality during periods when main crops are not cultivated.

Tanzania's agro ecological practices demonstrate a comprehensive blend of traditional knowledge and modern techniques aimed at creating a sustainable, resilient, and productive agricultural sector. The variety in crop and livestock production systems reflects the adaptability and innovation of Tanzanian farmers, who are conscious of their environment and the need for sustainable methods to ensure long-term agricultural productivity and food security.

Agroforestry, integrating trees and shrubs with crop and livestock farming, is notable for its environmental and economic benefits, such as enhancing biodiversity, and soil structure, and providing From a survey conducted in 15 regions and 15 districts with 245 farmers,additional income from timber and fruits. Crop diversity is also a key practice, with farmers cultivating a variety of crops to reduce dependency on one type of harvest and to increase resilience against adverse weather or market conditions.

Rainwater harvesting is a critical practice in Tanzania, addressing the challenge of water scarcity by collecting and storing rainwater for agricultural use. Integrated soil fertility management combines organic and inorganic inputs to maintain healthy soil, which is vital for sustainable crop production. Contour farming, which involves plowing along the contours of land, reduces runoff and soil erosion on slopes.

Reforestation efforts are in place to counteract deforestation, with initiatives to replant trees and restore the natural environment. Apiculture (beekeeping) is pursued for its role in pollination and as an

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additional source of income through honey production. Lastly, mixed crop, livestock, and fish production systems exemplify integrated farming approaches that optimize land use and diversify income sources.
In terms of crops, Tanzanian agriculture is diverse, with coffee and tobacco known as cash crops that contribute significantly to the economy. Staple crops like cassava, millet, maize, and various types of nuts and legumes such as groundnuts and sim-sim form the backbone of food security. Cotton is an important industrial crop, while rice and peas cater to both domestic consumption and export markets. A variety of fruits and vegetables, including bananas, sunflowers, and an assortment of vegetables like onions, watermelons, peppers, strawberries, and tomatoes, enrich the dietary diversity of the population and the market.

Livestock keeping is an integral part of Tanzanian agriculture, with various breeds of cattle (indigenous, exotic, and cross-breed) being raised. Goats and sheep are prevalent due to their adaptability and economic value. Pigs and poultry are also common, providing meat and eggs for consumption and sale. Interestingly, there is a mention of farmers who keep livestock but do not engage in agro ecological practices, indicating an area for potential growth in sustainable livestock management.

In Tanzania, various agro ecological practices are evident in farmers' fields. The most prevalent practices include intercropping and crop rotation, each accounting for 22% and 20% respectively, highlighting their preference for enhancing soil fertility and reducing pest risks. Cover cropping and agroforestry, each at 12%, demonstrate a commitment to soil conservation and the integration of trees into farming systems. The moderate adoption of crop diversity (9%) and rainwater harvesting (8%) reflects efforts to combat monoculture risks and water scarcity in Tanzania.

Other practices like integrated soil fertility management and contour farming, though less common, show growth potential. The least frequent practices include reforestation, apiculture, mixed cropping, livestock keeping, and fish production, suggesting a need for increased support in these areas.

In terms of crops, maize (24%) and vegetables (14%) are predominantly involved in these agro ecological practices, underscoring their significance in the Tanzanian agriculture sector. Beans (10%) and sunflowers (7%) follow, indicating crop diversification. Cassava, rice, groundnuts, and fruit trees each

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represent 5-6% of the adoption, while coffee, tobacco, cotton, sorghum, and sweet potatoes have lower representations.

Regarding livestock, poultry (46%) leads in terms of agro ecological practice involvement, signifying its central role in the Tanzanian farming systems. Goats (22%) and cattle (mainly indigenous 13%, exotic 2%, cross-breed 2%) also show considerable involvement. Pigs, sheep, and rabbits, however, have lower engagement levels, possibly due to cultural or resource constraints.

The agroecological practices with perceived high business potential, as mentioned by respondents in Tanzania

- Crop Diversity; Respondents recognize the business potential in cultivating a variety of crops. This includes practices like crop rotation and intercropping, which contribute to diversifying agricultural production.

- Agroforestry; Agroforestry practices, such as planting trees alongside crops, are highlighted as having high business potential. This includes the integration of trees, mixed farming, and practices like rainwater harvesting.

- Intercropping; Intercropping, or planting different crops together, is consistently mentioned as a practice with business potential. Farmers note the benefits of intercropping in terms of sustainability and increased revenue from the sale of diverse crops.

- Cover Crops and Contour Farming; Cover crops and contour farming are mentioned as practices contributing to soil conservation and fertility. These practices are seen as environmentally sustainable and potentially profitable.

- Livestock Keeping and Apiculture ; Integrating livestock keeping, including beekeeping (apiculture), with farming practices is identified as having business potential. This includes mixed farming, livestock keeping, and practices like beekeeping for honey production.

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- Integrated Soil Fertility Management ; Practices that focus on managing soil fertility in an integrated manner are highlighted. This includes the incorporation of organic matter, composting, and other soil fertility management practices.

- Mixed Farming; Mixed farming, which involves the cultivation of crops alongside livestock keeping, is mentioned as a practice with business potential. This approach allows farmers to diversify their income streams.

- Rainwater Harvesting ; Rainwater harvesting is identified as a practice that contributes to water conservation and could have business potential, particularly in regions with irregular rainfall patterns.

- Reforestation; Reforestation is mentioned as a practice with potential benefits for both the environment and business. Planting trees can contribute to soil conservation and potentially provide products like timber.

- Some respondents mention practices such as contour farming, apiculture, and the combination of agroforestry with other practices.

Challenges faced by Tanzania farmers while implementing agroecological practices

- A recurring theme is the shortage of capital, limiting farmers' ability to invest in inputs, technology, and education. Issues such as low capital, high seed costs, and lack of funds for farm implements are consistently mentioned.

- Farmers express concerns about unreliable markets, price fluctuations, and poor market conditions. Limited access to markets and the need for more favourable market structures are emphasized.

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- Climatic changes, including unpredictable rainfall and drought, emerge as significant challenges affecting agricultural productivity. Farmers also mention the impact of floods and the need for water accessibility.

- Limited knowledge of various aspects of agriculture, including organic farming, pest control, and good agricultural practices, is a prevalent concern. Education is identified as a key factor in addressing multiple challenges.

- Farmers cite challenges related to the availability and affordability of inputs, including seeds, pesticides, and fertilizers. High input costs, unavailability of organic pesticides, and limited access to quality seeds are noted.

- Poor infrastructure, lack of technology, and inadequate extension services are identified as obstacles. Access to processing machines, educational resources, and agricultural technologies are mentioned as essential needs.

- Specific challenges include conflicts between farmers and pastoralists, the invasion of crops by animals and insects, and the lack of agroecological pesticides. Additionally, there are mentions of the need for more organized farming practices, such as aqua agriculture.

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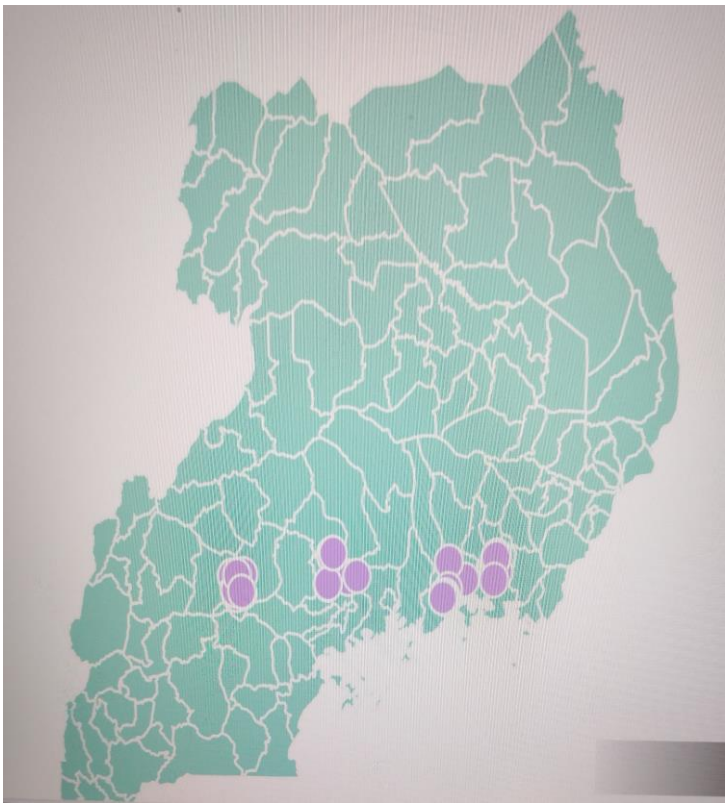
2.2 MAPING OF AGROECOLOGY IN EAST AFRICA

UGANDA

FIGURE 1: MAPPING OF AGROECOLOGICAL PRACTICES IN UGANDA



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TANZANIA

FIGURE 2: MAPPING OF AGROECOLOGICAL PRACTICES IN TANZANIA

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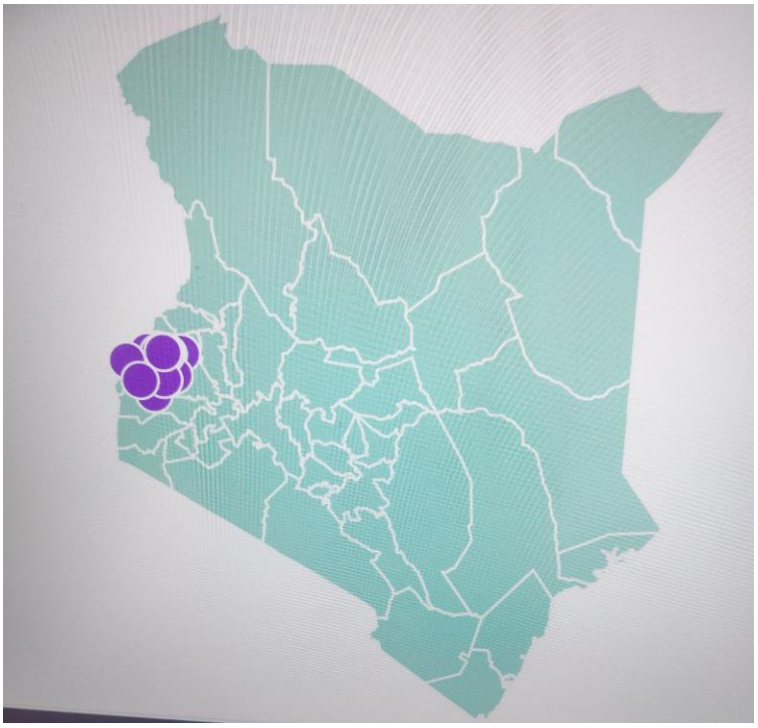
KENIA

FIGURE 3: MAPPING OF AGROECOLOGICAL PRACTICES IN KENYA



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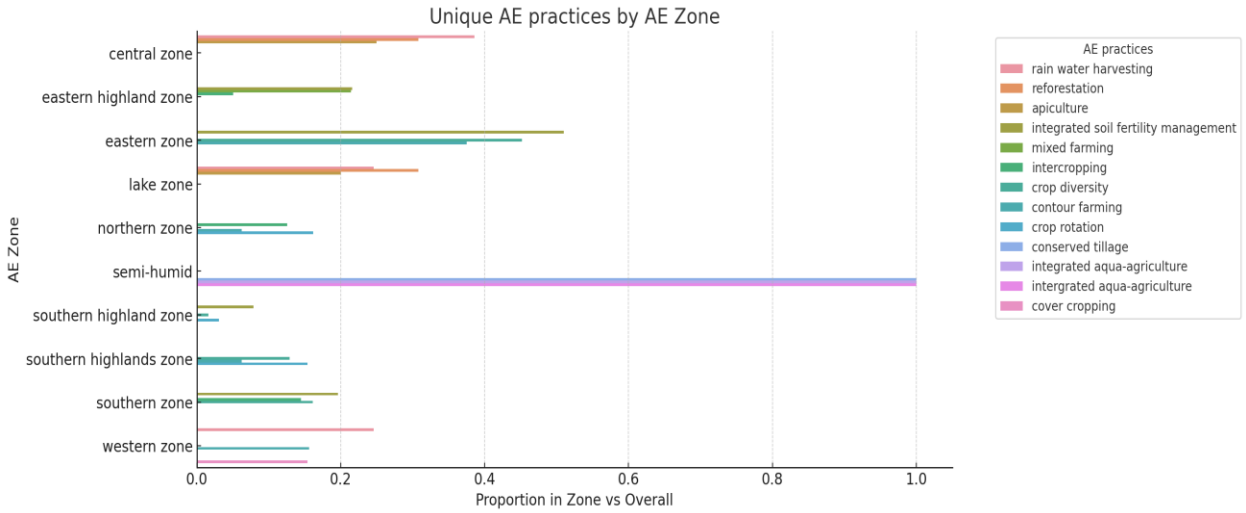
2.3 PRECISSION MAPPING OF AGROECOLOGICAL ZONES ANALYSIS

2.3.1 Agroecological zones and practices

Across the region literature and primary data collection indicated that agro ecological practices varied by agroecological zones. Rain water harvesting was considered a key practice in the central zones while Integrated aquaculture was more higher in the semi-humid.

FIGURE 4: AGROECOLOGCAL PRACTICES BY AGROECOLOGCAL ZONE



2.3.2 Agroecological practices categories

It was important to indicate which practices stood out across Eastern Africa, this is presented in Figure 5 below here. Intercropping scored higher however there is need to appreciate the correct combinations or what should be intercropped with what. This will be further addressed in WP6 of this project.

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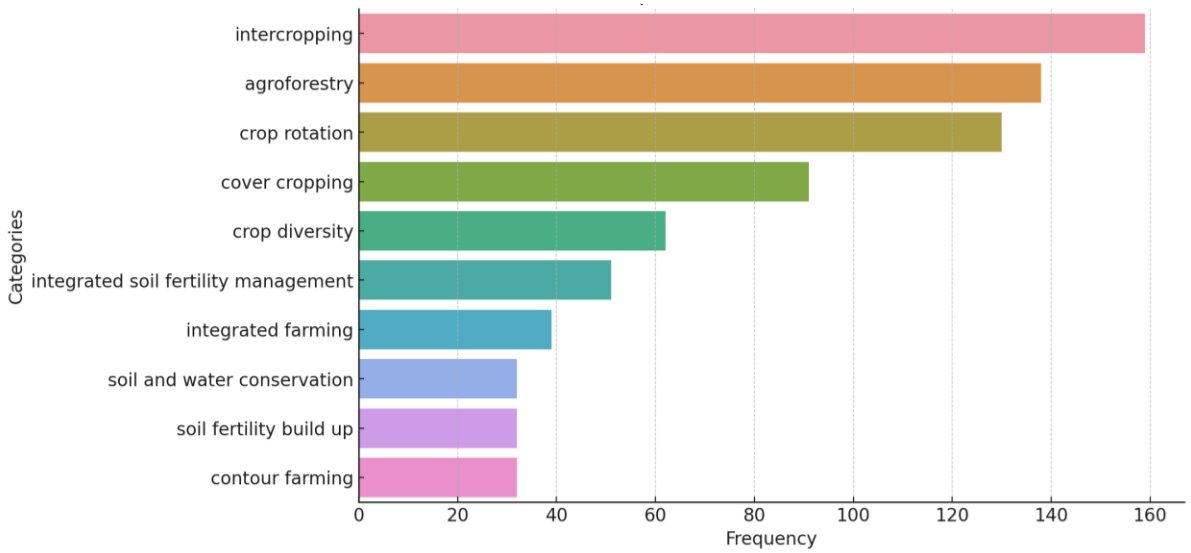
FIGURE 5: CATEGORIES OF AGROECOLOGICAL PRACTICES AND FREQUENCY



2.3.3 Small holder farm Agroecological practices based on crop farming

Small holder farming practices across the region varied in diversity and frequency of production, notable observations indicate dominance of maize and beans in the Central Zone while the Eastern Zonereported slightly similar scores but with mixed vegetables. The Humid and Semi-Humid Zone uniquely featured 'cassava' and 'ground nuts'.

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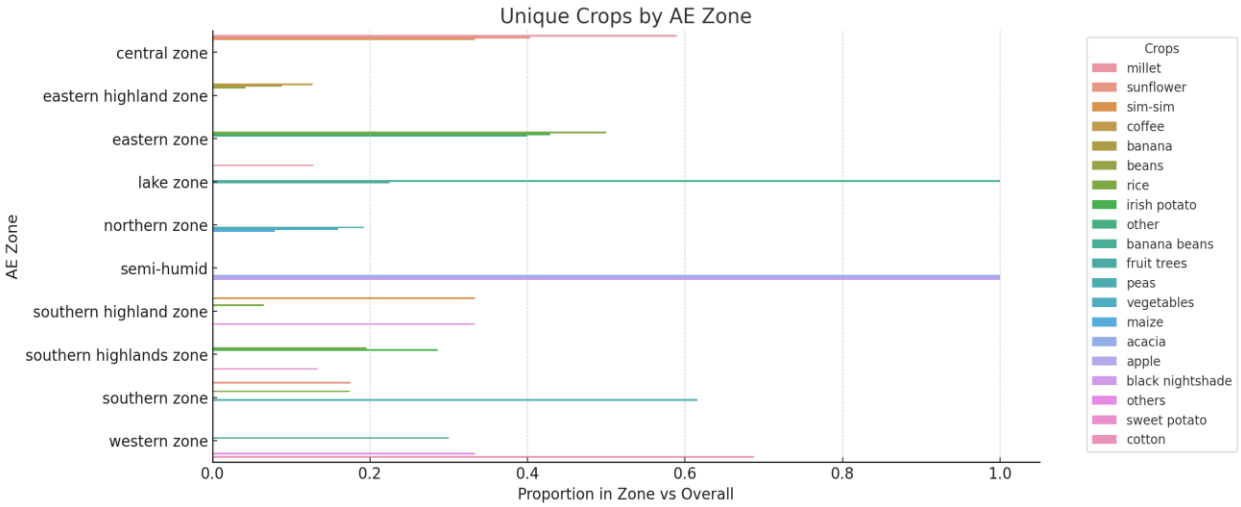
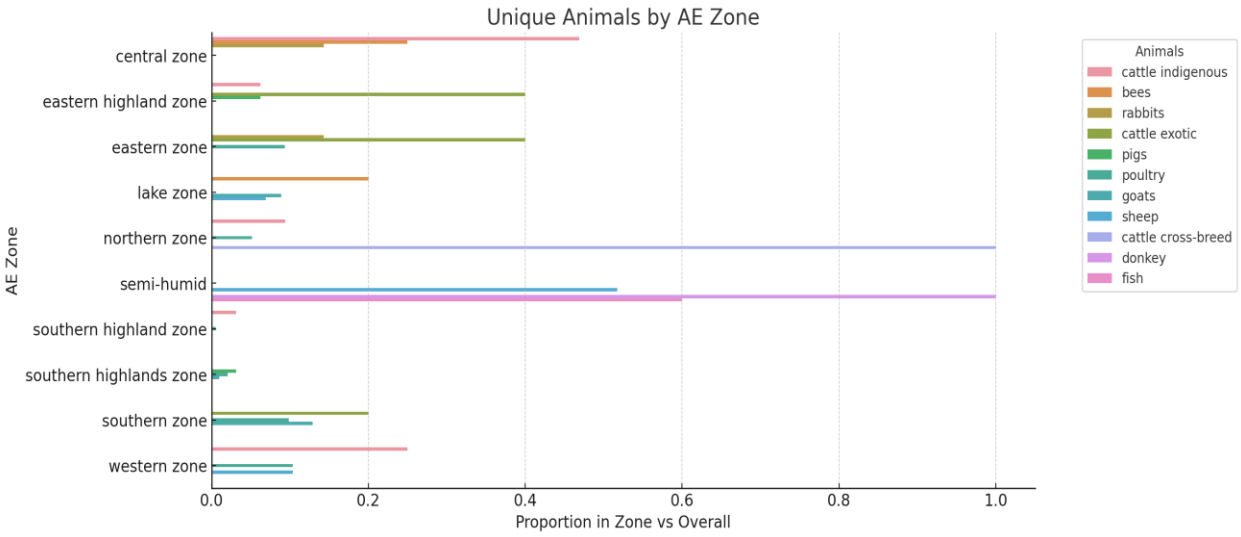
FIGURE 6: CROP PRODUCTION BY AGROECOLOGICAL ZONE



2.3.4 Livestock production practices by Agroecological zones

Results have indicated that there in the Central Zone, 'cattle indigenous' and 'bees' are more common. The Eastern Highland Zone has a notable presence of 'cattle exotic' and 'pigs' while the The Northern Zone uniquely features 'cattle cross-breed'

FIGURE 7:LIVESTOCK PRODUCTION BY AGROECOLOGICAL ZONES



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3 CONCLUSIONS

In conclusion, this report delves into the intricate landscape of agroecological practices in East Africa, focusing on Uganda, Kenya, and Tanzania. The study unveils a diverse array of sustainable farming techniques, including mixed farming and agroforestry, utilized by farmers in the region.The comprehensive analysis incorporates demographic insights, farming practices, and a thorough literature review to shed light on the multifaceted aspects of agroecology. Despite the evident benefits of agroecological practices, this study emphasizes the formidable challenges faced by farmers, ranging from labor intensity and market-related issues to expertise gaps and capital limitations. These obstacles pose significant barriers to the effective implementation and scalability of agroecological approaches. Recognizing these challenges is imperative for formulating targeted strategies to overcome them and foster the adoption of sustainable practices.

The study highlights the importance of context-specific solutions tailored to the unique challenges faced by smallholder farmers in East Africa. While agroecology holds immense potential in bolstering food security, improving farmer well-being, and enhancing soil health, there exists a pressing need for concerted efforts to bridge existing gaps and address barriers to implementation. The report emphasizes the importance of collaborative initiatives involving policymakers, researchers, and local communities to create an enabling environment for the successful integration of agroecological practices.

This research advocates for a holistic approach that not only maps existing agroecological practices but also seeks to understand and mitigate the challenges faced by farmers in the transition towards sustainable agriculture. By doing so, the study envisions a future where agroecology becomes a cornerstone in East Africa's agricultural landscape, contributing not only to environmental sustainability but also to the overall well-being of the region's farming communities.

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5 ANNEXES

A) LIMITATIONS IN THIS STUDY

- Logistical Difficulties: Due to the geographical dispersion of farmers, reaching and interacting with them was a complex task. This dispersed nature of farms made it challenging to conduct comprehensive and efficient data collection.

- Confidence and Trust Issues: There was a noted lack of confidence among agroecology institutions and farmers. Building trust with the farming community to share accurate and detailed information was a significant hurdle.

- Inconsistent Weather Patterns: The unpredictable weather not only affected the farming practices under study but also hindered the logistics of data collection, such as traveling to different locations and scheduling interviews and field visits.

- Financial Constraints: Limited budget and resources constrained the extent and depth of the data collection process. This affected the number of regions that could be covered and the duration of the study.

- Maintaining Contacts: Keeping in touch with local guides, data collectors, and respondents over time was challenging, especially in remote areas with limited communication infrastructure.

- Motivation of Personnel: Ensuring the motivation and engagement of local guides, data collectors, and respondents was difficult. This was critical for obtaining high-quality data and insights.

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B) LEASONS LEARNED

- Importance of Local Partnerships: Collaborating with local institutions, community leaders, and farmers themselves proved essential for gaining access and establishing trust within the communities during data collection.

- Flexibility in Approach: Adaptability to changing circumstances, such as weather conditions and farmers' availability, was crucial. A flexible approach allowed the research team to maximize data collection opportunities.

- Resource Allocation: Efficient management and allocation of resources are vital, especially in a context with financial and logistical constraints. Prioritizing key areas and respondents can lead to more effective data collection.

- Communication Strategies: Developing robust communication strategies, including the use of local languages and culturally sensitive approaches, enhanced the quality of data collected.

- Involving Farmers in Research: Engaging farmers not just as subjects but as active participants in the research process can bridge the gap between researchers and the farming community, leading to more relevant and applicable findings.

- Preparedness for Unpredictable Factors: Being prepared for unpredictable factors, such as weather changes, and having contingency plans in place, is essential for the smooth execution of field research.

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